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Appeal Brief

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PATENT & TRADEMARK OFFICE

Patent
Docket No.:653.001US1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of:
Edward W. Stark

Serial No.: 08/818,289

Filed: March 14, 1997
For: METHOD AND APPARATUS FOR OPTICAL INTERACTANCE AND TRANSMITTANCE MEASUREMENTS

Group Art Unit: 2505

Examiner: R. Rosenberger

BRIEF ON APPEAL

Commissioner of Patents and Trademarks
Washington, D.C. 20231

This is an appeal from the Office Action mailed on August 14, 1997, and the Advisory Action mailed on April 10, 1998 affirming the rejection of those claims.

This Brief is being filed in triplicate along with a check for $290.00 to cover the fee for the appeal. Appellants request the opportunity for a personal appearance before the Board of Appeals to argue the issues of this appeal. The fee for the personal appearance will be timely paid upon receipt of the Examiner=s Answer.

I hereby certify that this correspondence is being deposited with the United States Postal Service as First Class Mail in an envelope addressed to: Commissioner of Patent and Trademarks, Washington, D.C. 20231 on

26 June 1998 Signed: Mark A. Litman
Mark A. Litman, Registration No. 26,390

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REAL PARTY IN INTEREST

This Application is entirely owned by the inventor, Mr. Edward W. Stark.

RELATED APPLICATIONS AND APPEALS

Appellants do not know of any other pending U.S. Patent Applications which are on Appeal with subject matter and issues which overlap with this Application on Appeal. No Interference proceedings before the U.S.P.T.O. are known by Appellants to have any substantive relationship to the subject matter of this Appeal.

STATUS OF CLAIMS

Claims 6, 11-15, 17-19, 22-26, 35, 43, 45-53 and 56-71 have been allowed.

Claim 41 has been indicated as allowable upon being placed into independent form, including the limitations of all intervening claims.

Claims 1, 7, 33, 34, 36-40 and 42 have been finally rejected and comprise the substance of this Appeal.

STATUS OF AMENDMENTS

No Amendment to the claims or specification after final rejection has been submitted to the Patent and Trademark Office. All amendments previously submitted have been entered, with only certain claim numbering adjusted from the original amendments.

SUMMARY OF THE INVENTION

It is known that non-destructive examination of materials is particularly useful, including the use of a spectrophotometer to measure transmittance of clear liquids contained in transmission cells (Page 2, lines 9-27), diffuse transmittance or reflectance of large volumes of specimens (Page 3, line 33 through page 4, line 4) and interactance of scattering specimens (Page 2, line 28 through page 3, line 32). However, the inventor found that the use of multiple pathlengths in the accumulation of signal information with a single collector resulted in very non-linear signals relative to concentration (Page 2, lines 9-17). Diffuse, non-homogeneous, or layered specimens cause inaccuracies in spectroscopic determination of qualitative or quantitative characteristics of the specimen (Page 1, lines 11-30). Also, it is sometimes necessary to make diffuse transmission or diffuse reflection measurements of small samples. (Page 1, line 31 - page 2, line 7).

Optical interactance measurements bear some similarity to diffuse reflectance measurement in that (UV, visible light or infrared) illuminating energy is redirected to a detector by scattering within the specimen. This reflected radiation then undergoes absorption due to the composition of the material transversed within the specimen. However, interactance differs from diffuse reflectance measurements at least in the fact that the illuminated surface area is separated physically from the detection surface region, eliminating the collection of energy directly reflected from the illuminated surface area. In this sense, interactance measurement is similar to diffuse transmittance measurement which also provides separated illumination and detection surfaces (Page 2, line 28 through page 3, line 14).

The present invention improves the performance of optical interactance measurement instruments by:

1) providing illumination by way of a plurality of paths through a specimen (an analyte) having a characteristic to be measured,
2) sensing two or more independent signals developed at the same time or in sequence representing optical information from the specimen, and
3) processing and combining the signals in accordance with modeling techniques

(e.g., chemometric modeling) to minimize inaccuracies in spectroscopic determination of the qualitative or quantitative characteristics of the specimen based upon a model of the system response to variations in the concentration of the analytes and interferences present in the spectrum (Page 4, line 19 through page 5, line 6; and page 9, lines 5-35).

The geometry of the detection and source apertures is to provide substantially constant values of the spacing between all points within a given source aperture and a given detection aperture (page 8, line 32 through page 9, line 4). By having the availability of these constant values, the separate signals can be combined with linear or nonlinear modeling to address optical effects that interfere with the performance of the system (page 9, lines 5-35). For example, the arrangement preserves the distinction between the pathlengths t1 and t2 (Page 9, lines 25-35) and minimizes non-linearity caused by optically combining energy which has undergone absorption over different path lengths (Page 2, lines 12-17). Constant spacing also maximizes the differentiation of information derived from different depths within the sample (Page 10, lines 1-13).

ISSUES ON APPEAL

The sole remaining issue in this Application on Appeal is the patentability of Claims 1, 7, 34, 37-40 and 42 under 35 U.S.C. 103(a). Each of these claims has been finally rejected under 35 U.S.C. 103(a) as unpatentable over prior art admitted by Appellant in the specification (on pages 2-4), Borsboom (U.S. Patent No. 4,884,891) and Howarth (U.S. Patent No. 3,994,602). Appellants assert that the combination of references, even if combined as proposed by the Final Rejection of record, would not teach the invention as a whole as recited in the claims.

GROUPING OF CLAIMS

Solely for purposes of expediting this Appeal and to reduce the issues which must be addressed in this Brief on Appeal. Appellant elects to have the issues on this Appeal resolved according the following grouping of claims. Appellant reserving the right to assert independent patentability of the claims in the event of any enforcement of the U.S. Patent issuing from this Application.

Claim 1 shall stand or fall by itself under the issues in this Appeal, this claim being an independent method claim with its own distinct limitations.

Claim 7 shall stand or fall by itself under the issues in this Appeal, this claim being an independent apparatus claim with its own distinct limitations.

Claims 33 and 36 shall stand or fall together with the patentability of claim 33 because of the recitations Each independent signal corresponding to a particular path; and processing and combining said signals in accordance with appropriate chemometric modeling techniques to determine qualitative or quantitative characteristics of the material.

Claims 34 and 42 shall stand or fall together on the patentability of claim 34, this claim adding the additional limitation that the step of defining at least one of said paths and said surfaces areas is done by areas on opposite surfaces of the material.

Claims 37 and 38 shall stand or fall separately, these claims each identifying aperture means of different path configurations which are mutually exclusive. The rejection asserts that the references may be combined to show a concentric arrangement (such as that recited in claim 38) and so the combination can not also show the parallel arrangement.

Claim 39 and 40 shall stand or fall together with the patentability of claim 39 with respect to the limitation that the aperture means define one surface area of the at least two paths so that the surface area is common to the two paths.

ARGUMENTS OF APPELLANTS

The rejection of record is believed to be fairly summarized as follows:

1) Borsboom shows a method and apparatus for optical measurement of a phenomena affected by light back-scattering by surface and/or volume refraction.

2. The specification (cited by the PTO in the rejection, pages 2-4) teaches that in the prior art, interactance measurements are made using "...a central aperture surrounded a small distance away by a ring aperture..." and a ring aperture would be circular. Borsboom particularly shows an arrangement with this structure, with a central aperture **2** and a circular ring **7** around the central aperture, the rejection especially pointing out Figure 4 of Borsboom.

3. The ring of the prior art and Borsboom are both "...extended in length..." and "...the total length of said extended surface area being substantially greater than the mean distance separating the two areas defining the light path through the material..."

4. The arrangement of the prior art in the specification is acknowledged as showing only a single path through the sample, with Borsboom being cited as showing light scattered back through the mixture of emitting **3** and receiving **4** fibers in the same element (indicating that this is a "second path through the object".

5. It is then asserted that it is known to measure light passing through a material at two different distances. This teaching is supported in the Office Action by citation of Howarth.

6. Howarth (Figures 6 and 7) teach two different path lengths through the material, neither path being directly back to the emitting source.

7. It is then asserted as a legal conclusion that it would have been obvious to provide means

(as in Howarth) to measure two different distances through the material because the art recognizes that this is useful.

8. It is asserted that provision of this means would have been performed by adding a second ring at the desired second distance, especially as Borsboom suggest a plurality of rings (e.g., column 3, line 61 through column 4, line 1).

9. It is then asserted as a legal conclusion that arrangements other than concentric circles for the illumination and detection areas would be obvious because it is asserted that it is the transmission of light through the material, and not the particular geometry of the light source and light detectors, that is of functional importance.

Even if each and every assertion made in this rejection were accepted as accurate, the rejection would not establish even *prima facie* obviousness of the invention as claims. In addition to this, some of the reliance placed upon the teachings of the reference is misplaced with respect to the quality of the teaching provided by the references.

<u>Claim 1 shall stand or fall by itself under the issues in this Appeal, this claim being an independent method claim with its own distinct limitations.</u>

At least one critical aspect of the invention as claimed which is not taught or suggested by the references used in the rejection is the recitation of :

> "...at least one of said surface areas of each of said paths being extended in length **<u>at substantially constant spacing from the other surface</u>** of each of said paths..."

This limitation requires that either the emitting surface area be **<u>constantly spaced</u>** from the surface area transmitting illumination into the material or that the surface area transmitting illumination be **<u>constantly spaced</u>** from the emitting surface. This is most easily effected by having one of the surface areas present at the center of a concentric succession of rings of surface areas. For example, a series of concentric illumination transmission rings may

circle a center of an emitting surface area or a series of emitting surface area rings may circle a center of an illumination surface area. Each of these configurations would provide the two surface areas (emitting and illumination) of each path at constantly spaced locations. As noted in the "Summary of the Invention," this constant spacing is important in one aspect of the invention claimed in this Appeal to provide an accurate basis for providing meaningful results.

As recognized by the Examiner, the admitted prior art discloses only a single path through the sample, whereas Applicant recites:

> "...a plurality of different transmission paths...defining each of said paths by corresponding <u>and separated</u> surface areas on said materials." (Emphasis added).

The rejection of record asserts that Borsboom discloses a second path. However, this asserted second path is merely the possible interchange of transmitted light between the bundled emitters and receptors in the core. This asserted second path is not characterized by separated surface areas but rather by intermixed emitters and detectors. As noted in column 2, lines 25-46 of Borsboom, this configuration is essential to Borsboom's objective of measuring opaque objects.

Claim 1 (and 7) recites that

> "...at least one of said surface areas of each of said paths being extended in length at substantially constant spacing from the other surface."

The distribution shown by Borsboom only supports a teaching of a random or ordered distribution of optical emitters and collectors in the center of the sensor head. The mere fact of distribution of optical emitters and detectors in the core (rather than a single emitter or a single detector) prevents this limitation from being met for Borsboom's second path.

From Borsboom's teaching it can be determined that the preferred diameter D of the central fiber is approximately equal to or larger than twice the radial distance s (column 2 line 66 to col. 3, line 3). Because the emitters are non-uniformly and asymmetrically distributed in an area with dimensions that are significant with respect to diameter of the concentric circle of collectors , the central surface area of each of the paths will not be at substantially constant spacing from the other surface area. Looking at Figure 4, where the Office Action asserts a concentric distribution of optical fibers, it can be readily seen that the spacing between the central emitting fibers **3** and the exterior fibers **7**, even if they were only collecting fibers, is not at substantially constant spacing. The spacing between the central fibers and exterior fibers is clearly eccentric, depending upon the position of the central fibers within the core. Neither the teachings in the specification, Borsboom, or Howarth. teach that this type of spacing specifically shown by Borsboom should be eliminated. Without such a teaching, the claim is unobvious from the teachings of these references. There is no teaching of

> "...at least one of said surface areas of each of said paths being extended in length at substantially constant spacing from the other surface area..."

Without such a specific teaching in the art, the claim can not be asserted to be obvious.

Additionally, Applicant in claim 1 recites

> "...the total length of said extended surface area of said each of said paths being substantially greater than the mean distance separating said corresponding and separated surface areas defining each of said paths;"

Borsboom states that

> "...the apparatus according to the invention is characterized in that in said sensor head, at least one solid optical illuminating fibre and at least one juxtaposed optical detection fibre are disposed with their optical axes parallel to each other..." (Column 2, lines 25-29).

One juxtaposed optical detection fiber cannot form "the extended surface area" of

Applicant's claim. Borsboom has no teaching concerning the advantages of using a plurality of optical detection fibers arranged in a ring. Howarth does not teach the use of extended surface areas for illumination or detection. Howarth shows (Figure 7) that his two detectors are typically oriented in the direction of flow of the material in a pipe spaced 1" and 3" from the source (Figure 6 and column 5, lines 1-4). He also states that

> "...mounting of the gauge of the present invention on a pipeline carrying pulp ... may be relatively difficult. This is especially true when the pipe diameter is relatively small or relatively large;..."

These difficulties argue against the use of extended surface areas "...substantially greater than the mean distance separating said ... surface areas defining each of said paths;" which would only increase the difficulty. This is another specific limitation in the claims which is not specifically taught or suggested by the references. To that end, this limitation is another aspect of the unobvious subject matter of the invention as claimed.

Claim 1 also specifically recites that:

> "...sensing a plurality of independent signals developed at the same time or in rapid sequence representing optical information obtained from a spectrum related to the analytes and interferences within said material."

The Office Action states (Page 6, lines 2-3) that

> "...claim 1 only states that the detected light represents such information, it does not claim any method step sufficient to extract such information..."

This argument is presented merely to limit the subject matter which must be shown by the art of record to establish an issue with respect to patentability, and does not reflect on the substance of the claim under 35 U.S.C. 112. The sensing of signals representing optical information obtained from a spectrum (not specimen as stated in the Office Action, page 5, line 16) is known in the art, as described, for example, in the Norris references of record (e.g., Page 2, lines 28-31 and page 4, lines 8-12). The specification also teaches "...a

detection system, such as a diode-array spectrophotometer…" (page 6, lines 13-14) which inherently provides signals representing optical information obtained from a spectrum comprising many measurement wavelengths. "Sensing" recited in the claims therefore comprises the necessary method step.

The Office Action notes (Page 6, lines 6-7) Borsboom's disclosure of "wavelength dependent measurements." However, the actual disclosure in the reference continues "…in which the central optical fiber **2** is used only..." because "…the parallel juxtaposed fibres **7** will receive no reflected light." (column 5, lines 32-44). This requirement of Borsboom is contrary to the limitation recited in claim 1 on Appeal for "…passing illumination along a plurality of different path lengths."

The Office Action also notes (Page 6, lines 7-8) that Borsboom teaches on column 6, line 10 teaches "using a spectrophotometer" but fails to consider the immediately preceding language that

> "After the [calibrating] solutions have been obtained, the linear scattering and absorption coéfficients can be determined by the dilution method as used as a standard procedure in chemical analyses…" (Column 6, lines 7-10).

There is no teaching that a spectrophotometer could be used with the claimed fibre-optic apparatus. Therefore the asserted teaching of the use of a spectrophotometer has no bearing on the obviousness of the present claims.

Claim 1 (and 7) specifically recites that each of the signals received by the sensing means comprises a spectrum, that is by definition multiple wavelengths (cf. Webster's Seventh New Collegiate Dictionary). Borsboom clearly describes the use of

> "…a monochromator or a colour or interference filter **16**... depending on the use of the apparatus or on the absorption characteristics to be investigated, for example, translucent material." (Column 5, lines 6-9).

Each of these devices provides only a single measurement wavelength, and this is further supported by the later description that

> "…in the case of measurements with regard to meat...an interference filter is used with a transmission at 560nm..." (Column 5, lines 9-13).

Borsboom, in addition to teaching only monochromatic devices, does not provide any positive indication that multiple wavelengths are useful for translucent materials as in the practice of the invention claimed by Applicant in this Application. Similarly, Howarth teaches the use of a common wavelength in that part of the specification applicable to the description of Figures 6 and 7 (e.g., column 5, lines 1-9) which was referenced by the Examiner. As Howarth clearly shows a single "common" wavelength, the combination of Borsboom and Howarth fail to show any device with multiple wavelengths as described with the use of a spectrum as recited in claims 1 and 7. No single wavelength can differentiate between a plurality of analytes and interferences as enabled by the practice of the invention claimed by Applicant in claims 1 and 7. The additional features now in claims 1 and 7 further provide recitations of unobvious subject matter between the claimed invention of claims 1 and 7 and the combination of Borsboom and Howarth.

Furthermore, the claims now recite "…from a spectrum related to the analytes and interferences within said material..." which is not asserted to be shown by the references.

Claim 1 (and equivalently claim 7) further recite:

> "…processing <u>and combining</u> said signals in accordance with appropriate <u>chemometric</u> modeling techniques <u>and determination of model parameters during the calibration process</u> to determine qualitative or quantitative characteristics of the material…" (emphasis added)

The Office Action recognizes (Page 6, lines 9-12) that the Amendment filed on January 20, 1998 added the limitation of "chemometric" and notes that:

> "…Borsboom, column 6, line 10, which teaches using the probe of that

reference for chemical analyses."

This description in Borsboom is only a description of the "dilution method" used to determine the linear scattering and absorption coefficients of the calibrating liquids and has no relationship to "...using the probe of that reference for chemical analyses." The teaching of Borsboom is wholly directed to "...determining a phenomenon that is affected by the surface and/or volume reflection of light, for example, the colour and/or brightness of the material" (Column 2, lines 22-24) and the "...relationship between the colour scale for visual perception and the absorption signal measured with the sensor head." (Column 7, lines 1-3) For this purpose, it is essential that the probe of Borsboom provides for measurement of the surface reflection of light, which is specifically excluded by the recitation in the claims.

Borsboom does not teach combining the signal from the central fiber with that of the parallel juxtaposed fibers. In the case of opaque materials,

> "...the parallel juxtaposed fibres 7 will receive no reflected light..." (column 5 lines 32-33).

Borsboom's calibration process for translucent materials involves two steps, first measuring:

> "...deflection of the signal from the central fiber..." (column 5 lines 60-61)

and separately Borsboom measuring:

> "...the deflection of the detector at the parallel juxtaposed fibres..." (Column 5 lines 65-67).

Borsboom clearly uses these signals separately, the first for scattering and the second for absorption measurements. He does not teach any form of chemometric modeling or determination of model parameters during the calibration process.

As partially referenced by the Examiner, Borsboom suggests

> "The position of the optical fibers within the sensor head relative to each other that is optimal for absorption depends on the nature of the material to be investigated and, if desired, is determined by experimentation. For this purpose, a sensor head could be made in which a large number of juxtaposed fibers of diameter d is arranged concentrically around a central optical fiber with an increasing radius. Measurements made with such a sensor head gives a good picture of the amount of reflected light that has entered the fibres arranged concentrically in rings, and hence the light reflection as a function of distance from the light beamed into the material being investigated."

Borsboom does not combine the signals from the different rings as is now claimed in claims 1 and 7. Borsboom simply uses different rings, one at a time, to determine the optimal spacing of his juxtaposed detection fibre(s).

Howarth does disclose the use of the ratio of the signals at a single wavelength from two detectors spaced at different distances from a single source to measure consistency. A simple ratio of two signals at one wavelength does not comprise "chemometric modeling" as now recited in claims 1 and 7. Chemometric modeling requires multivariate, i.e., multi-wavelength calibration .

Reference to the accompanying and hand-marked figures taken from Borsboom and Howarth are instructive in showing the failure of the references to teach the invention as claimed. Looking at the handmarked (in red) Figure 4 of Borsboom, one can readily see that even though there are many available pathways from the emitting optical fibers (the shaded fibers **3**) to the collector fibers (the unshaded, open fibers **4** and the fibers lining the outer wall **8**), the path lengths create non-independent signals. All of the received illumination in optical fibers **4** are the result of many different path lengths. All of the received illumination in the optical fibers around the border **8** are also the result of many different path lengths. Therefore, the structural arrangement shown by Borsboom does not allow for these limitations in claim 1 (and claim 7) to be met.

Although the present invention allows for the core to comprise optical fibers to be either collectors involved in signal capture or emitters involved in providing the separate signals of constant path length, the degree of variation provided as between the core fibers and the surrounding fibers versus the bundle of emitters and receptors in a core, is relatively insignificant. As can be seen from the reproduced Figure 4 of Borsboom, the relative degree of variation between fibers **3** and fibers **4** is significant. The presence of both collectors and emitters in the core also increases the degree of variation between the distances between the core optical fibers and the surrounding optical fibers.

The structure of Howarth (or the "admitted" prior art) has no teaching that would motivate one of ordinary skill in the art to change this central and essential configuration of Borsboom. Figure 2, in fact, rather than showing two pathways, merely shows how the optimum displacement distance between the windows **17** and **18** can be selected (column 3, lines 5-26). Figure 6 shows variations in signals received from between only two surface areas for the purpose of selecting a distance between the windows **17** and **18** which minimizes the effects of consistency on the desired bulk reflectance measurement (Column 4, lines 18-42). Howarth then describes (Column 4, lines 43-62) that

> "any of the sloping portion of the curves below line **60** (which obeys the above Beer's law) are suitable for use in consistency measurement, assuming of course that the curve represents the bulk optical properties as discussed above. In Fig. **7** a third window **61** is displaced from the source a greater distance than window **62** the placement corresponding to the 3 inch and 1 inch curves of Fig. **6**. Radiation detectors D1 and D2 associated with the window receive radiation of a common wavelength which is ratioed as illustrated tp produce the dashed ratio curve of Fig. **6**. Such wavelength, as shown in Fig. **8** is within the range of 0.8 to 0.95 microns. Such range is effective for both bleached and brown stock."

Therefore, in the special circumstances of a) measuring paper pulp, b) that the sloping portion of the curve obeys Beer's law, c) that the curve represents the bulk optical properties of the pulp, d) that the ratio of received radiation at stwo specific distances

provides a relatively linear relationship to pulp consistency, and e) that the variation in interfering characteristics such as color (bleached or brown) can be eliminated by the choice of a single wavelength, Howarth states (Column 4, lines 63-68) that

> "...it is preferred to measure the ratio of received radiation in at least two different window locations as illustrated by the dashed curve labeled Ratio 1/3."

This is as far removed from an improvement to "interactance" measurements as is the use of two path lengths in the measurement of clear liquids as cited in the prior art of the specification. The mere existence of Howarth's use of two paths in this special case does not suggest that it is obvious to use multiple paths by the addition of a second ring in an arrangement as shown by Borsboom, with the intent or expectation of improving inetractance measurements. The practice of the Howarth construction has not been shown to have any specific relevance to the performance of an interactance measuring device. It would therefore not be obvious to take a configuration for use in the technical environment of Howarth, apply it to the difference technical field of Borsboom, and expect an improvement in interactance measurements.

Specifically, there is no motivation to use solely emitting or collecting optical fibers in the core of Borsboom, and no basis for asserting that the benefits described by the present invention would be an expected result of those unmotivated changes. There is no basis for using chemometric modeling on the signals received from the separate paths with an expectation of improved quality in the resultant data. The combination of references specifically fails to provide motivation for or teach the invention as claimed. Without the motivation for change, the selection of random elements of the prior art and the modification of the prior art does not rise to the level of proof required for establishing even a *prima facie* case of obviousness.

Claim 7 shall stand or fall by itself under the issues in this Appeal, this claim being an independent apparatus claim with its own distinct limitations.

In addition to all of the reason given above for the patentability of claim 1, claim 7 also is even more restrictive and delimiting than claim 1. Claim 7 requires that:

> "...at least one of said surface areas of each of said transmission paths being substantially constantly spaced from its corresponding surface area..."

Without any teaching or inherent existence of this limitation, the combination of references can not sustain a rejection under 35 U.S.C. 103.

Claims 33 and 36 shall stand or fall together with the patentability of claim 33

Claims 33 and 36 shall stand or fall together with the patentability of claim 33 because of the recitations

> "...each independent signal corresponding to a particular path; and processing and combining said signals in accordance with appropriate chemometric modeling techniques to determine qualitative or quantitative characteristics of the material..."

These claims specifically recite two limitations which are not obvious from the teachings of the "admitted prior art," Borsboom and/or Howarth.

In combination with the "...said paths being contained within the boundary defined by an extended surface area."(e.g., the concentric arrangement) none of the references suggests or discloses that:

> "...each independent signal corresponding to a separate path; and processing and combining those signals in accordance with appropriate chemometric modeling techniques to determine qualitative or quantitative characteristics of the material."

The "admitted" prior art does not provide a plurality of different paths, and it has not been so asserted or supported in the rejections of record. Borsboom shows a plurality of paths (because of the number of fiber optic elements and receptors), but these do not produce independent signals but are additively combined. Howarth shows a single example of two paths (Figure 7), but these separate paths are not within the boundaries of

one of the other surface areas. Additionally, chemometric modeling is not performed on the data (Howarth showing only ratioing of the two signals at a single wavelength from the construction in Figure 7). Even if the references are accepted as showing everything for which they have been cited, they do not collectively teach that the invention as claimed is obvious to one of ordinary skill in the art at the time that the Application was filed.

Claims 34 and 42 shall stand or fall on the patentability of claim 34, this claim adding the additional limitation that the step of defining at least one of said paths and said surfaces areas is done by areas on opposite surfaces of the material.

This limitation of defining at least one of said paths and said surface areas by areas on opposite areas of the material has not even been specifically asserted to be shown by any art of record. In addition to the fact that the claims from which these claims depend are patentable, these additional, unobvious limitations, further define subject matter which is patentable over the art used in the rejection.

Claims 37 and 38 shall stand or fall separately, these claims each identifying aperture means of different path configurations which are mutually exclusive.

The rejection asserts that the references may be combined to show a concentric arrangement (such as that recited in claim 38) and so the combination can not also show the parallel_arrangement. There is no assertion that any specific reference shows a parallel arrangement or other claimed configuration of emitting areas and receptor areas for the aperture means. Without some actual teaching of the configuration and its benefit, the rejection of record is clearly inadequate

Claim 39 and 40 shall stand or fall with the patentability of claim 39 with respect to the limitation that the aperture means define one surface area of the at least two paths so that the surface area is common to the two paths.

This limitation of having an aperture means define one surface area of the at least two

paths so that a surface area is common to the two paths has not even been specifically asserted to be shown by any art of record. In addition to the fact that the claims from which these claims depend are patentable, these additional, unobvious limitations, further define subject matter which is patentable over the art used in the rejection.

SUBMITTED FOR THE INVENTOR
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BY SCHWEGMAN, LUNDBERG,
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Respectfully submitted:

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APPENDIX

CLAIMS ON APPEAL

1. A method for improving optical interactance measurements comprising the steps of:

passing illumination along a plurality of different transmission paths through an interior portion of a material having a characteristic to be measured;

defining each of said paths by corresponding and separated surface areas on said material, one of said surface areas for passing illumination into said material and the second of said surface areas for passing transmitted illumination from said material for detection, at least one of said surface areas of each of said paths being extended in length at substantially constant spacing from the other surface area of said each of said paths, the total length of said extended surface area of said each of said paths being substantially greater than the mean distance separating said corresponding and separated surface areas defining said each of said paths;

sensing a plurality of independent signals developed at the same time or in rapid sequence representing optical information obtained from a spectrum related to the analytes and interferences within said material in response to said illumination passing along said different paths, each independent signal corresponding to a particular path; and

processing and combining said signals in accordance with appropriate chemometric modeling techniques and determination of model parameters during the calibration process to determine qualitative or quantitative characteristics of the material.

7. Apparatus for optical interactance measurements of an interior portion of a material, said measurements being effected by passing illumination through portions of the material comprising:

aperture means for defining corresponding and separated surface areas on said material for defining each of a plurality of transmission paths through an interior portion

of said material, one of said surface areas for passing illumination into said material and the second of said surface areas for passing transmitted illumination from said material for detection, at least one of said surface areas of each of said transmission paths being extended in length and substantially constantly spaced from its corresponding surface area, the total length of said extended surface area of said each of said transmission paths being substantially greater than the mean distance separating said corresponding and separated surface areas defining said each of said transmission paths;

means for directing illumination onto said illumination surface areas and along said transmission paths;

means for sensing optical information indicative of said interior portion of said material developed by illumination passing along said transmission paths to said detection surface areas of said transmission paths;

means, responsive to said sensing means, for developing a plurality of independent signals corresponding in number to said plurality of paths, each of said signals representing said optical information obtained in a spectrum related to analytes and interferences within said material; and

means for combining and processing said signals in accordance with appropriate chemometric modeling techniques and determination of model parameters during the calibration process to determine quantitative or qualitative characteristics of said material.

33. A method for improving optical interactance measurements comprising the steps of:

passing illumination along a plurality of different paths through an interior portion of a material having a characteristic to be measured;

defining each of said paths by corresponding and separated surface areas on said material, one of said surface areas for passing illumination into said material and the second of said surface areas for passing transmitted illumination from said material for detection, at least one of said surface areas of each of said paths being

extended in length at substantially constant spacing from the other surface area of said each of said paths, the total length of said extended surface area of said each of said paths being substantially greater than the mean distance separating said corresponding and separated surface areas defining said each of said paths, an extended surface area of one of said paths being contained within the boundary defined by an extended surface area of another of said paths and being substantially surrounded by the extended surface area of said another of said paths sensing a plurality of independent signals developed at the same time or in rapid sequence representing optical information obtained from within said material in response to said illumination passing along said different paths, each independent signal corresponding to a particular path; and

processing and combining said signals in accordance with appropriate chemometric modeling techniques to determine qualitative or quantitative characteristics of the material.

34. The method of claim 1 including the step of defining at least one of said paths and said surface areas by areas on opposite surfaces of said material.

36. Apparatus for optical interactance measurements of an interior portion of a material, said measurements being effected by passing illumination along a plurality of different transmission paths through an interior portion of a material having a characteristic to be measured, comprising:

aperture means operative to define each of said paths by corresponding and separated surface areas on said material, one of said surface areas for passing illumination into said material and the second of said surface areas for passing transmitted illumination from said material for detection, at least one of said surface areas of each of said paths being extended in length at substantially constant spacing from the other surface of said each of said paths, the total length of said extended

surface area of said each of said paths being substantially greater than the distance separating said corresponding and separated surface areas defining said each of said paths,, an extended surface area of one of said paths being contained within the boundary defined by an extended surface area of another of said paths and being substantially surrounded by the extended surface area of said another of said paths;

means for directing illumination onto said illumination surface areas and along said transmission paths;

means for sensing optical information indicative of said material developed by illumination passing along said paths to said detection surface areas of said paths;

means, responsive to said sensing means, for developing a plurality of independent signals corresponding in number to said plurality of paths, said signals representing said optical information obtained from within said material; and

means for processing and combining said signals in accordance with appropriate chemometric modeling techniques to determine qualitative or quantitative characteristics of the material.

37. The apparatus of claim 7 wherein said aperture means are operative to define said surface areas of each of said paths to be parallel.

38. The apparatus of claim 7 wherein said aperture means are operative to define said surface areas of each of said paths to be concentric.

39. The apparatus of claim 7 wherein said aperture means are operative to define one surface area of at least two of said paths to be common to said two paths.

40. The apparatus of claim 39 wherein said aperture means are operative to define said common surface area to be centrally located with respect to said at least one extended surface area defining each of said two paths.

42. The apparatus of claim 7 or claim 36 wherein said aperture means are operative to define said illumination and sensing areas for at least one of said paths to be on opposite surfaces of said material.

ALLOWABLE CLAIM

41. The apparatus of claim 39 wherein said aperture means are operative to define said common surface areas as the detection surface area.

ALLOWED CLAIMS

6. A method for improving optical interactance measurements comprising the steps of:

passing illumination along a plurality of different transmission paths through an interior portion of a material having a characteristic to be measured;

defining each of said paths by corresponding and separated surface areas on said material, one of said surface areas for passing illumination into said material and the second of said surface areas for passing transmitted illumination from said material for detection, at least one of said surface areas of each of said paths being extended in length at substantially constant spacing from the other surface area of said each of said paths, the total length of said extended surface area of said each of said paths being substantially greater than the distance separating said corresponding and separated surface areas defining said each of said paths;

providing optical directionality for radiation passing through at least one of said extended surface areas by orienting the optical axes at the respective probe surface area at an angle with respect to the surface of said material and generally towards the said

corresponding and separated surface area on said material;

sensing a plurality of independent signals developed at the same time or in rapid sequence representing optical information obtained from within said material in response to said illumination passing along said different paths, each independent signal corresponding to a particular path; and

processing said signals in accordance with appropriate modeling techniques to determine qualitative or quantitative characteristics of the material.

11. Apparatus for improving optical interactance, transmittance and reflectance measurements comprising:

an elongated probe having a body portion and a tip portion, the body portion comprising a central tubular element surrounded by an annular outer element;

the tip portion having a central aperture which communicates with said central tubular element and a plurality of rings which communicate with said annular outer element;

the rings in said tip portion being angled with respect to the longitudinal axis of the probe;

a number of fiber optic bundles whose number corresponds to said plurality of rings being disposed within said outer element, each bundle being arranged at one end to exit at a respective ring and, at the other end, at least one such bundle being connected to a source of illumination; and

optical means disposed in the central tubular element for receiving optical information resulting from applied illumination to a specimen from said central aperture from different paths through a specimen and for conveying said information to a sensing device so as to develop signals representing said specimen optical information.

12. The apparatus of claim 11 wherein each fiber optic bundle is arranged at the other end to be connected to a source of illumination.

13. The apparatus of claim 11 also including means to process said signals in accordance with appropriate modeling techniques to minimize inaccuracies in spectroscopic determination of qualitative or quantitative characteristics of the specimen.

14. The apparatus of claim 11 wherein said tip portion and fiber optic elements at the tip portion are angled at approximately 26E with respect to the longitudinal axis of the probe.

15. The apparatus of claim 11 including at least one lens disposed in said central tubular element for focusing the optical information received in said central aperture and means responsive to the focused information for forming a signal representing said information.

17. The apparatus of claim 15 wherein said means responsive to the focused information includes a fiber optic element for conveying the focused optical information to a detector responsive to the optical information conveyed by the fiber optic element.

18. The apparatus of claim 11 also including fiber optic means and a detector for providing a signal representative of the illumination received by the specimen.

19. The apparatus of claim 15 including means for allowing the focusing of said lenses to be changed.

22. In a method of using apparatus for improving optical transmittance and reflectance measurements comprising means for providing illumination to a specimen having a characteristic to be measured along a plurality of different paths, at a probe tip of said apparatus, means for sensing optical information, at a central aperture of said probe tip, developed by said illumination provided from an illuminated specimen, means, responsive to said sensed optical information, for developing a plurality of independent signals corresponding in number to said plurality of paths, said signals representing said

optical information obtained from said specimen, and means for processing said signals in accordance with appropriate modeling techniques to minimize inaccuracies in spectroscopic determination of quantitative or qualitative characteristics of the specimen, said method including the step of providing a further source of illumination, arranging said probe tip adjacent a near side of a specimen of small size, arranging the further source of illumination on a far side of said specimen, and using said probe tip so that reflected energy from said specimen is directed to said central aperture and/or energy transmitted by said further source through said specimen is directed to said central aperture.

23. In a method as in claim 22 including the step of selectively choosing an operational mode of reflectance, transmittance or combined reflectance and transmittance by selectively applying said illumination and selectively sensing reflected or transmitted illumination.

24. In a method of using apparatus for improving optical transmittance and reflectance measurements comprising means for providing illumination to a specimen having a characteristic to be measured along a plurality of different paths at a probe tip of said apparatus, means for sensing optical information, at a central aperture of said probe tip, developed by said illumination provided from an illuminated specimen, means, responsive to said sensed optical information, for developing a plurality of independent signals corresponding in number to said plurality of paths, said signals representing said optical information obtained from said specimen, and means for processing said signals in accordance with appropriate modeling techniques to minimize inaccuracies in spectroscopic determination of quantitative or qualitative characteristics of the specimen, said method including the steps of providing a further detector for developing an electrical signal responsive to illumination, arranging said probe tip adjacent a near side of a specimen of small size, arranging said further detector on a far side of said specimen, and using said probe tip so that reflected energy from said specimen is directed to said

central aperture and/or energy transmitted by said probe is detected by said further detector.

25. In a method as in claim 24 including the step of selectively choosing an operational mode of reflectance, transmittance or combined reflectance and transmittance by selectively applying said illumination and selectively sensing reflected or transmitted illumination.

26. Apparatus for improving optical interactance, and transmittance measurements comprising:

an elongated probe having a body portion and a tip portion, the body portion comprising a central tubular element surrounded by an annular outer element;

the tip portion having a central aperture which communicates with said central tubular element and a plurality of rings which communicate with said annular outer element;

a plurality of fiber optic bundles whose number corresponds to said plurality of rings being disposed within said outer element, each bundle being arranged annularly within a respective ring at said tip end for receiving optical information from within a particular material and, at the other end, each bundle being adapted to be connected to a detector for developing an independent signal corresponding to an illumination path through said material; and

said central tubular element containing optical elements connected with a source of illumination, which illumination will exit at the central aperture.

35. A method for improving optical interactance measurements comprising the steps of:

passing illumination along a plurality of different paths through an interior portion of a material having a characteristic to be measured;

defining each of said paths by corresponding and separated surface areas on said material, at least one of said surface areas of one of said paths being extended in length at substantially constant spacing from the other surface area of said one path;

sensing a plurality of independent signals developed at the same time or in rapid sequence representing optical information obtained from within said material in response to said illumination passing along said different paths, each independent signal corresponding to a particular path; and

processing said signals in accordance with appropriate modeling techniques to determine qualitative or quantitative characteristics of the material;

wherein said steps of passing illumination and sensing are provided by an instrument for said interactance measurement and said method further includes the steps of moving said instrument a predetermined distance away from said material and performing a reflectance measurement of said material.

43. A method for effecting optical interactance and reflectance measurements relative to a material, having a characteristic to be measured, comprising the steps of:

providing optical means, at a first predetermined distance from a surface of said material, for defining on said material at least one illumination surface area and at least one detection surface area which are separated said surface areas on said material defining at least one transmission path through an interior portion of said material for performing interactance measurements, at least one of said surface areas of one of said paths being extended in length at substantially constant spacing from the other surface area of said one path;

providing said optical means at a second predetermined distance, relative to the surface of said material, for defining illumination and detection surface areas on said material which are at least partially superimposed thereby defining a surface area on said material for performing diffuse reflectance measurements;

illuminating said illumination area and detecting optical information received

from said detection area for developing signals representing said optical information obtained from said material in response to said illumination; and

processing said signals detected by said optical means in accordance with appropriate modeling techniques to determine quantitative or qualitative characteristics of the material.

45. The method as in claim 43 wherein said optical means, at said first distance, defines a plurality of distinct illumination surface areas and at least one detection surface area, whereby a plurality of different transmission paths are defined in said specimen.

46. The method as in claim 45 wherein said optical means, at said first distance, defines at least one of said illumination surface areas as extended in length.

47. The method as in claim 45 wherein said optical means, at said first distance, defines said at least one detection surface area as extended in length.

48. The method as in claim 43 wherein said optical means, at said first distance, defines at least one of said illumination surface areas and said at least one detection surface areas as extended and parallel.

49. The method as in claim 43 wherein said optical means, at said first distance, defines at least one of said surface areas to be extended and to define another of said surface areas to be distinct and contained within the boundary defined by said extended surface area.

50. The method as in claim 43 wherein said optical means, at said first distance, defines said illumination and detection surface areas to be parallel.

51. The method as in claim 43 wherein said optical means, at said first distance, defines said illumination and detection surface areas to be concentric.

52. The method as in claim 43 wherein said optical means, at a plurality of said second distances, defines a plurality of illumination and detection surface areas which are at least partially superimposed corresponding to said plurality of said second distances.

53. The apparatus of claim 26, wherein said rings in said tip portion are angled with respect to the longitudinal axis of the probe.

56. A method for improving optical interactance measurements of a material comprising the steps of:

(a) passing illumination along a plurality of different paths through an interior portion of a material having a characteristic to be measured;

(b) said different paths of illumination each comprising a distribution of substantially equidistant illumination means surrounding a central detection aperture;

(c) said central detection aperture comprising optical connections within said central detection aperture which are connected to a detection system;

(d) sensing in said detection system a plurality of independent signals developed at the same time or in rapid sequence representing optical information obtained from within said material in response to said illumination passing along said different paths, each independent signal corresponding to a particular path; and

(e) processing said signals in accordance with modeling techniques to determine qualitative or quantitative characteristics of the material.

57. The process of claim 56 wherein said central detection aperture consists of optical connections within said central detection aperture.

58 The process of claim 57 wherein said optical connections within said central aperture comprises fiber optics.

59. The process of claim 57 wherein said distribution of substantially equidistant illumination means comprises a circular distribution of illumination means.

60. The process of claim 57 wherein substantially equidistant illumination means comprise fiber optics.

61. The process of claim 59 wherein substantially equidistant illumination means comprise fiber optics.

62. The process of claim 61 wherein said fiber optics within each circular distribution of illumination means are within individual ring apertures surrounding a central detection aperture and are present within an aperture which is sloped towards said central detection aperture.

63. The process of claim 57 wherein fiber optics within individual ring apertures surrounding a central detection aperture are within apertures which are concentrically spaced around said central detection aperture.

64. The process of claim 61 wherein said fiber optics within individual ring apertures surrounding a central detection aperture are present within an aperture which is sloped towards said central detection aperture.

65. Apparatus for improving optical interactance, transmittance and reflectance measurements comprising:

(a) a probe comprising a body portion and a contacting portion;

(b) said contacting portion comprising:

(i) a central detection area comprising at least one optical connection to a detection system; and

(ii) at least two outer illumination areas, each outer illumination area being connected to illumination means;

(c) said at least two outer illumination areas being optically connected to at least one source of illumination which can provide different signals at the same time or in rapid sequence to each of said at least two outer illumination areas;

(d) said at least two outer illumination areas and said central detection area forming at least two different paths of illumination between said at least two illumination areas and said central detection are, said different paths of illumination each comprising a distribution of substantially equidistant illumination means surrounding said central detection area.

66. The apparatus of claim 65 wherein said central detection area consists of optical connections to a detector system.

67. The apparatus of claim 66 wherein said optical connection of said central detection area to said detection system comprises fiber optics.

68. The apparatus of claim 66 wherein said optical connection of said at least two illumination areas and said at least one source of illumination comprises fiber optics.

70. The apparatus of claim 67 wherein said central detection area consists of optical fibers which consist of a detection system.

71. The process of claim 58 wherein said central detection aperture consists of fiber

optics which consist of a detection system.